

## ARS COMBINATORIA AND TIME: LLULL, LEIBNIZ AND PEIRCE\*

### I. Introduction

In the present study I explore some connections between three very important philosophers: Llull, Leibniz and Peirce. The following line of argument is related, almost exclusively, to their commonly shared idea of *ars combinatoria* (considering everything at a high level of abstraction) and their shared view of time, which is totally consistent with that idea of *ars combinatoria*. Accordingly, I shall defend the following: first, that Llull, with his *Ars generalis* (1274-1308), influenced Leibniz in his conception of *ars combinatoria*, present mainly in *Dissertatio de arte combinatoria* (1666), and in *On Universal Synthesis and Analysis* (1683). Second, that Leibniz influenced Peirce about the issue in several writings.<sup>1</sup> Third, that Llull with his *ars combinatoria* (especially in his ternary period) influenced Peirce in his division and classification of signs.

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\* AUTHOR'S NOTE: I owe thanks to Anthony Bonner for his generous and thoughtful criticism of an earlier version of this paper. Though my debts are far wider, I particularly wish to acknowledge the help of Andreas Müller, who called my attention to the similarity between Llull's and Peirce's semiotics. I want also to express my gratitude to Harald Pilot, who helped me with explanations and bibliography related to Leibniz's conception of time.

<sup>1</sup> *The Collected Papers of Charles Sanders Peirce*, Vols. I-VI, ed. Ch. Hartshorne & P. Weiss (Cambridge, Mass., 1931-5); Vols. VII-VIII, ed. A. Burks (Cambridge, Mass.), 1958. Abbreviated CP followed by volume and pages. In this case, see CP 2.227-273, with writings dating from 1897, and his *Syllabus* from ca. 1902.

The first claim has been already convincingly argued by several scholars, but the second and third claims have been neither endorsed, nor argued, by anyone.

Finally, I shall claim that all of them share a similar conception of the structure of time, if we consider that structure from the topological point of view. And I shall show that such conception of the structure of time is totally consistent with their view of an *ars combinatoria*.

## PART 1: COMBINATORY MECHANISMS

### II. Llull

The *ars combinatoria* of Ramon Llull is a method by mean of which he tries to find and explore (by using certain rules) all possible combinations (or manifestations) of primitive concepts; the so-called divine dignities. This method was conceived as a new way of answering, with mathematical infallibility, questions of any type, and, consequently, of obtaining true knowledge.

The *ars combinatoria* evolves from an initial stage (quaternary period) to a second more simplified one (ternary period). The *Ars generalis ultima* (or *Ars magna*), the *Ars brevis* (a summary of the former) and *Logica nova*, in which Llull compiles all the main logical features of the structure of the Art, are the principal works of the ternary period. This structure is an "artistic" one, not a logical one (in the sense of traditional or Aristotelian logic), and it is realized mainly through his *ars combinatoria*. In fact, for Llull, as for Leibniz and Peirce, the *ars combinatoria* is a part of that logic that permeates the mind and the universe, allowing man to know the latter by using the former in such a way that there are no definite limits in his approach to the truth.

Llull was a strong realist. The basic concepts in the *ars combinatoria* are the dignities which, in turn, are actually God's properties operating in nature.<sup>2</sup> Entities, having in different varieties those properties, constitute a ladder of being. So, we first have God, then the angels, and successively heaven, human

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<sup>2</sup> In the *Ars generalis ultima* (ternary period), Llull makes a distinction between the attributes of God or dignities in their abstract forms: *bonitas*, *magnitudo*, *eternitas* (whose semblance in the world is *duratio*), *potestas*, *sapientia*, *voluntas*, *virtus*, *veritas* and *gloria*, and in their concrete forms: *bonum*, *magnum*, *durans*, *potens*, *sapiens*, *volens*, *virtuosum*, *verum*, *gloriosum*.

beings, and so forth, down to the lowest creatures and the four elements (earth, water, air and fire).<sup>3</sup>

In every period, quaternary and ternary, combinations are the essential basis of Llull's *ars combinatoria* as a logical system. The mechanism of these combinations are given mainly by the figures. The constant figures in both periods are the first figure (Figure A) and Figure T. The first one expresses the absolute principles or divine dignities; the second one expresses the principles of relation.

Figure A stands for God, Who is represented by a point at the center of a corresponding circle. The circumference of that circle is divided into sixteen compartments (quaternary period), or nine compartments (ternary period). Llull labelled these compartments with the letters of the alphabet, from B to R, standing for the dignities of God. With these divine attributes Llull forms (in the quaternary period) one hundred and twenty binary combinations. He obtains this number by using (in the *Ars compendiosa inveniendi veritatem*) combinations without repetitions of sixteen concepts taken two at a time, thus obtaining,

$$\binom{16}{2} = \frac{16 \cdot 15}{2 \cdot 1} = 120.$$

In this way he gets, for example, BC (Goodness is great), BD (Goodness is eternal), and so on (see Graph 1). In the *Ars demonstrativa*, Llull uses combinations with repetitions of sixteen elements taken two at a time, and so, he obtains,

$$\binom{16+2-1}{2} = \binom{17}{2} = \frac{17 \cdot 16}{2 \cdot 1} = 136.$$

In these two works of the quaternary period, Figure T differs from the other figures because it has only fifteen compartments: B, E, H, L, O, C, F, I, M, P, D, G, K, N, Q (see also Graph 1). It has five triangles of different colors inscribed in a circle with a T at its center.

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<sup>3</sup> In the quaternary period, the four elements of the Elemental Figure (which is square) have different colors: earth is black, water is green, air is blue, and fire is red. It is curious that the components of Figure A, representing the dignities of God, are written in blue. Blue is the color of heaven. The color red is used for the vices (of Figure V of Virtues and Vices, in which the virtues are blue), and for falsehood (Z). However, red is also used for three principles of Figure T (beginning, middle and end), and for that portion of Figure S which represents the acts of memory forgetting, intellect not knowing, and will loving and hating. It looks as if the color red were related to Hell, or to the passions of the body (because blood is red as well).

The typical method of Figure T is first to go from the universal to the particular (descending), and second, to go from the particular to the universal (ascending). In this way, the intellect can ascend to the universal or descend to the particular, according to the case in question.

In any Art (ternary or quaternary periods), with the exception of his *Ars demonstrativa*, in which he uses combinations with repetitions of  $m$  elements taken  $n$  at a time, all the main combinations are without repetitions (of  $m$  elements taken  $n$  at a time). I think that the main reason is that Llull's Art is a method by which all sciences become demonstrable, universally and incontrovertibly. Thus, in his *Ars demonstrativa* the artist can use not only propositions like "Goodness is great" (BC), that provides some information, but also "Goodness is good" (BB), that provides no information. In demonstrations, in general, we can allow all these types of combinations. But when Llull uses the Art as a method of "finding truth", he only allows combinations without repetitions. This is so, because the propositions involved must provide some information. We can find these combinations without repetitions in the secondary figures in the quaternary period. However, in the ternary period, in the Third figure of the *Ars brevis* or the *Ars generalis ultima* Llull starts with combinations without repetitions of the nine letters that are common to Figures A and T. Thus, we get a triangle of thirty six combinations.

$$\binom{9}{2} = \frac{9 \cdot 8}{2 \cdot 1} = 36.^4$$

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<sup>4</sup> However, the examples given by Llull suggest that we can combine principles from either Figure A or Figure T individually, or from both figures together. From the compartment BC in the triangle, we can get, in Figure A, goodness (B) and greatness (C), or in Figure T, difference (b) and concordance (c). Continuing the use of small letters for the principles of Figure T, we would have the following permutations of four elements taken two at a time (i.e. B, C, b, c):

$$4P2 = \frac{4!}{(4-2)!} = 12,$$

or BC, Bb, Bc, CB, Cb, Cc, bB, bC, bc, cB, cC, cb. All these relations are new. In the Fourth Figure, we again have new relations. Insofar as we have nine letters in the alphabet, the combinations without repetitions of nine letters taken three at a time generate eighty-four compartments:

$$\binom{9}{3} = \frac{9 \cdot 8 \cdot 7}{3 \cdot 2 \cdot 1} = 84.$$

They are BCD, CDE, ... BCd, CDc, ..., etc. For a more complete account of the issue, see Anthony Bonner, *Selected Works of Ramon Llull (1232-1316)*, 2 vols. (Princeton, N.J., 1985), Vol. I, pp. 587-597.

In Graph 2 (a), we have the triangular representation of the nine letters that are common to Figures A and T.

Llull used different types of geometrical figures. For the principal figures, A or T, in any period, he used circles. In the quaternary period, he used a square for the elementary figure. The secondary figures of A and T in which the combinations are performed are triangular. But, in the ternary period only the Third Figure is triangular; it has the combinations of the principles of Figures A and T (see Graph 2 (a)). The Fourth Figure is a combination of the other three figures (see Graph 2 (b)). As a matter of fact, in this ternary period (after 1290), there is a simplification and systematization of the Art: for example, the elementary theory which was foundation of the Art in the quaternary period disappears, and analogy is replaced by the syllogism, which is not the same as the Aristotelian syllogism.<sup>5</sup> Moreover, in the ternary period, Llull reduced the number of figures from twelve to four, in which change the only figures left from the quaternary period are A and T. The principles of Figure A are essential, they are the divine attributes of God (or dignities). The principles involved in figure T are the accidental ones, or relative predicates.<sup>6</sup>

Based on the possible combinations of the three circles of the Fourth Figure, the final form of Llull's, triadic combinatorial mechanism was represented by the *tabula generalis* (presented in the work of that name, and found complete in his *Ars generalis ultima*, and in an abbreviated form in the *Ars brevis*), in which he represented all the possible combinations without repetitions of the components of both Figures A and T.

The first *tabula* allowed us to obtain eighty-four triadic combinations without repetitions:

$$\binom{9}{3} = \frac{9 \cdot 8 \cdot 7}{1 \cdot 2 \cdot 3} = 84.$$

(See Graph 3)

<sup>5</sup> The Aristotelian and classical syllogisms are different. The Aristotelian syllogism has three figures, depending on the position of the middle term in the premises. The classical medieval syllogism has four figures, derived from splitting the first Aristotelian figure into two. Thus the first figure is now MP, SM / SP, and the fourth figure is PM, MS / SP. Llull's logic, in turn, has four figures (in the ternary period): A T, the Third Figure and the Fourth Figure. Figures A and T allow one to obtain propositions, the third figure gives us the immediate inferences, and the fourth figure generates syllogisms (mediate inferences). In addition, Llull's syllogism depends not only on the form, but on the meaning of the letters employed.

<sup>6</sup> The principles of any figure are expressed through an alphabet of sixteen or nine letters (according to the period). They are not variables but shorthand notations.

These combinations constitute the so called "compartments". Each of them are at the head of a column containing further variations. Every column, in turn, contains twenty combinations without repetitions:

$$\binom{6}{3} = \frac{6 \cdot 5 \cdot 4}{1 \cdot 2 \cdot 3} = 20.$$

(See Graph 4)

The total number of possible compartments we can obtain are:

$$84 \cdot 20 = 1,680$$

The complete reproduction of the 1,680 combinations could take, at least, four pages. This is the reason I only present, as an illustrative example, the twenty combinations of the first column. The letter *t*, which appears in lower case among the other upper case letters, indicates that all the letters before the *t* belong to Figure A, and the other letters after *t* belong to Figure T. In order to show the triadic character of the *tabula*, A. Bonner<sup>7</sup> suggested that we could use upper case letters for the Figure A, and lower case letters for the Figure T. For example, instead of writing BCtB, we could write BCb.

The essence of the Art does not consist only in combinations, but in the metaphysical reduction of all created things to the dignities, which are the transcendental aspects of reality, and the comparison of particular things in the light of the dignities. And, through the application of the divine attributes (or dignities) the multitude of different objects of the mind can be reduced to one supreme mental unity, the Divine Unity.

It must be stressed that Llull's Art, in any period, is mainly an ascending method, going from the positive to comparative stages, in which we can recognize the manifestations of the dignities in this world (going from *bonus* to *melius*). Then it goes from *melius* to *optimum*, i.e., from comparative to superlative stages, where we arrive at the dignities themselves. In the quaternary period, Llull uses analogical arguments. In the ternary period he uses syllogisms. Therefore, if we can master the combinatorial art, a general science would be possible. It is noteworthy that the same possibility was defended by both Leibniz and Peirce. And what is most remarkable is that they grounded that possibility by also appealing to their new versions of an *ars combinatoria*.

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<sup>7</sup> *Op. cit.*, Vol. I, 596.

### III. Leibniz

In this section I shall be concerned only with the topics developed by Leibniz which have some important connections with Llull's combinatorial methods and Peirce's ideas on this issue.

Leibniz's idea of constructing a universal and automated language is related to certain very important topics, such as:

1. Leibniz's conception of logic.
2. Leibniz's *Ars combinatoria*.
3. Leibniz's alphabet of human thoughts.

1. According to Leibniz, logic can be understood in two ways: as an *ars inveniendi* and as an *ars demonstrandi*.

As an *ars inveniendi*, the function of logic is to find or discover truth, following a systematic and progressive order. As an *ars demonstrandi*, logic investigates the eternal elements of truth. Here, the function of logic is to demonstrate already discovered truths. Accordingly, the *ars inveniendi* has a synthetic character and the *ars demonstrandi* an analytic one. It is obvious that not only the terms<sup>8</sup> but also the meanings ascribed to them are closely related to Llull's *Ars inveniendi* and *Ars demonstrativa*.

2. The theory of combinations or *ars combinatoria* is almost the totality of Leibniz's *ars inveniendi*.

The application of the logic of combinations to inventive logic is carried out by Leibniz in the following way:

Let any term be analyzed into formal parts, i.e. let there be a definition given, and let these parts again be a definition of the terms of the definition, down to simple parts, i.e. indefinable terms.<sup>9</sup> The irreducible terms are represented by the simplest signs.

In *De arte combinatoria*, Leibniz uses numbers as those simple signs. The definition of a term is the combination of its constituent simple terms. Leibniz represents that combination as a product of numbers, i.e. of those numbers representing the simple terms. Leibniz combines these first order terms in pairs

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<sup>8</sup> According to Leibniz, the terms are «items before the mind». This is how this idea of Leibniz is characterized in H.-N. Castañeda, «Leibniz's Concepts and their Coincidence *Salve Veritate*», *Nous* 8 (1974), 385.

<sup>9</sup> Leibniz, *De arte combinatoria*, Av. I, 195, in *Leibniz's Logical Papers*, ed. G.H.R. Parkinson (Oxford: Clarendon Press, 1966), p. 4.

(terms of second order). Correspondingly, combining terms of first order in triples, Leibniz obtains the third order terms, and so forth. In this way, every term of a high order will be represented as a product of numbers. Thus, each term has its own characteristic number. Moreover, that product will be as well the definition of the term represented by that product.

In *De arte combinatoria* Leibniz explains the mechanism of his combinatory system; all the factors or divisors of a given term are its possible predicates; they express not only the qualities that form the comprehension of a given term, but those factors are also involved in the definition of that term. Then, the terms of that combination are its prime factors. In order to find them, we can use the general formula,  $2^k - 1$ , where  $k$  is the number of prime factors that are elements in the definition of a given term. For example, the number of partial combinations when  $1 \leq k \leq 4$  is the following:

$$\begin{aligned} 2^1 - 1 &= 1 \text{ combinations, for } k=1 \\ 2^2 - 1 &= 3 \text{ combinations, for } k=2 \\ 2^3 - 1 &= 7 \text{ combinations, for } k=3 \\ 2^4 - 1 &= 15 \text{ combinations, for } k=4 \end{aligned}$$

Thus, 15 would be the total number of possible combinations. Accordingly, to find all the divisors of a given number (for instance, 210) is equivalent to finding all the possible predicates of a given subject (where 210, in our instance, represent that subject). To achieve this goal, Leibniz proceeds as follows:

- (a) Take all the prime factors of that number: 2, 3, 5, 7.
- (b) Take the combinations of the four prime factors taken two at a time: 2·3, 2·5, 2·7, 3·5, 3·7, 5·7.
- (c) Take the combinations of the four factors taken three at a time: 2·3·5, 2·5·7, 3·5·7, 2·3·7.
- (d) Finally, take the combinations of the four factors taken four at a time: 2·3·5·7. This product is 210.

This part (a)-(d) looks like an application of Llull's combinations without repetitions to arithmetic:

$$\binom{4}{1}, \binom{4}{2}, \binom{4}{3}, \binom{4}{4},$$

In 1683, Leibniz writes again about the same subject in *On Universal Synthesis and Analysis*. Here the analogy with Llull is even more obvious: Leibniz uses letters as Llull did, and he considers combinations without repetitions as did his predecessor. Let us assume that we have a notion  $y = abcd$ ; it has as simple elements (the factors already discussed before) the notions  $a, b, c, d$ . If we form combinations without repetitions of these four elements taken two at a time, we get:



$$\begin{array}{lll} \text{(i)} & a b = e & a c = m & a d = n \\ & b c = p & b d = q & c d = r \end{array}$$

(ii) The combinations without repetitions of the four elements taken three at a time will be:

$$\begin{array}{ll} a b c = s & a b d = v \\ a c d = w & b c d = x \end{array}$$

We have again  $\binom{4}{2}$ ,  $\binom{4}{3}$  and  $\binom{4}{4}$ . Furthermore, all these combina-

tions are the predicates of  $y = a b c d$ .<sup>10</sup>

3. In his *ars combinatoria* Leibniz made a parallelism between logic (*ars in-veniendi*) and metaphysics. The simplest or prime terms are the monads, and the composite terms are the *phenomena bene fundata*, or events, or states of affairs in this world. The subject and predicate compose a proposition in which the *predicatum inest subjecto*. Thus, Leibniz's combinations are primarily of dignities.

Leibniz himself acknowledged Llull's influence on his work. For example, as early as 1666, in his *Dissertatio de arte combinatoria*, he mentioned Llull's combinatorial system (*Ars magna*), and said: "To us it seems thus: the terms from whose complexions [or combinations] there arises the diversity of cases in the law are persons, things, acts and rights..."<sup>11</sup>

Sometimes Leibniz criticized Llull's *ars combinatoria*, complaining that Llull had chosen arbitrarily the simplest terms for his alphabet. According to Leibniz, the simplest (or first) terms have to allow us to reproduce all possible thoughts (of course, by the combinations of those terms). Leibniz even gave a list of such terms. They were conceived as constituting the alphabet of human thoughts which, in turn, was the basic vocabulary of his *universal language*. Leibniz believed that starting from the terms of the alphabet, and using appropriate combinations, all reasoning could be reduced to a quasi-mechanical operation.

<sup>10</sup> The analogy with Leibniz's earlier *ars combinatoria* of 1666 is direct. Leibniz himself was aware of such an analogy: «I have said more of this in my *De arte combinatoria*, when I had scarcely entered on manhood...» (Parkinson, *op. cit.*, p. 11.) As a matter of fact, in 1686, Leibniz presented another version of his *ars combinatoria*, introducing a mixture of geometry, arithmetic and algebra.

<sup>11</sup> «*Dissertatio de arte combinatoria*, Applications of Problems I and II» in G.W. Leibniz, *Philosophical Papers and Letters*, ed. L.E. Loemker (Dordrecht: Reidel, 1969), p. 83.

Here is present again Lull's vision of the possibility of constructing an algebraic mechanism which, starting from the symbols of the basic vocabulary, combines the symbols of a language. For Leibniz, the universal language is that language which was used by Adam in Paradise and was lost because of the confusion of languages at the Tower of Babel.

It must remain clear that the universal language was not conceived as a disguised arithmetic that would require a perfect mental calculus. It is a real language, that we can speak and write, but its structure is a logical one. However, this complex project of constructing a universal language was never really accomplished because it required the prior solution of some crucial problems, such as, for example, the creation of a *characteristica* and the construction of an *Encyclopaedia*, problems which Leibniz did not succeed in solving.

#### IV. Peirce

Peirce's theory of signs is ultimately based on his categories of Firstness, Secondness and Thirdness. In fact, they are categories, not only of our perceptual experience, but mainly of the most general modes of being. Following Peirce's notation for categories,<sup>12</sup> I shall use the numbers 1, 2 and 3 to designate these categories. Thus:

- 1 = Firstness, a mode of being that does not have reference to anything else and is classified under the heading "quality". Its manifestations include feeling, emotion, and imaginations.
- 2 = Secondness, a mode of being that is the experience of effort and that is classified under the rubric "fact" or "actual fact" (whereas Firstness was classified under the rubric of "possibility"). Its manifestations include perception, experience, individual existence, existent objects, events, etc.
- 3 = Thirdness, a mode of being that links 1 and 2 under the heading of "law", "continuity of process", "mediation", and "habit". Its manifestations include thought, mind, and cognition. Thirdness conjoins the inner world of fancy with the outer world of fact or actual behavior. It is the synthesis or mediation that springs out of plural consciousness.

Before and after 1905 Peirce has given two types of definitions of signs: (a) one gives only the triadic elements involved in the process of semiosis. I shall call it "static definition":<sup>13</sup>

<sup>12</sup> CP 8.376.

<sup>13</sup> R. Marty, in his forthcoming *The Category of Relational Structures as Foundation of Peirce's Phenomenology and Semiotic*, calls this type of definition «global triadic».

A *sign* or *representament*, is a First which stands in such a genuine triadic relation to a Second, called its *object*, as to be capable of determining a Third, called its *interpretant*...<sup>14</sup>

(b) The other type of definition that I shall call "dynamic definition" (R. Marty calls this type "analytic"), is the one in which we consider the relations among the elements of the process of semiosis. For example, in Ms. 318 (c. 1907), Peirce wrote:

A sign is anything, or whatsoever mode of being, which mediates between an object and an interpretant; since it is both determined by the object relatively to the interpretant, and determining the interpretant in reference to the object, in such wise as to cause the interpretant to be determined by the object through the mediation of this sign.

I claim that Peirce's combinations of *n*-trichotomies are based on his static type of definition of sign. This is because, in those trichotomies, Peirce only considered the elements of the process of semiosis: sign, object and interpretant. He does not take into account the relationship among the elements of that process.

Peirce's basic classification of signs, according to the elements of the sign-action (or semiosis), and considering which categories are involved in each of them, is shown in Graph 5.

Peirce then arranged these classes of signs in a triangular table, according to the affinities they share. He obtained ten classes of signs by applying the following restrictions: starting with the top row of Graph 5, we can only associate down and to the left. As a result, Peirce obtained three triadic divisions (Peirce's three-trichotomies of signs).

Peirce gave two triangular tables. The first one is as follows: (see Graph 6).

I. Qualisign,	e.g. a feeling of red
II. (Rhematic) Iconic Sinsign,	e.g. an individual diagram
III. Rhematic Indexical Sinsign,	e.g. a spontaneous cry
IV. Dicent (Indexical) Sinsign,	e.g. a weathercock or a photograph
V. (Rhematic) Iconic Legisign,	e.e. a diagram, apart from its factual individuality
VI. Rhematic Indexical Legisign,	e.g. a demonstrative pronoun

<sup>14</sup> CP 2.274.

VII. Dicent Indexical Legisign,	e.g. a street cry
VIII. Rhematic Symbol (Legisign),	e.g. a common noun
IX. Dicent Symbol (Legisign),	e.g. a proposition
X. Argument,	e.g. a syllogism

In a partial draft of a letter to Lady Welby (December 28, 1908), Peirce talked again about his first three-trichotomies of signs. He presented there his second triangular arrangement (see Graph n. 7).

I shall modify the numbering given by Peirce. In order to fit the combinatorial mechanism, my numbering will be from right to left (see Graph 8).

In fact, we get a modification of Peirce's arrangement in Graph 4.

Moreover, Peirce says in that draft of the letter to Lady Welby (in reference to his second triangular arrangement of Graph 7) that the number in the upper left describes the Object of the Sign, the number in the upper right describes its Interpretant, and the lower number describes the sign itself. Combining Peirce's categories with modalities, we can consider that 1 signifies the possible modality, that of an Idea, 2 signifies the necessary modality, that of an Occurrence; and 3 signifies the necessary modality, that of a Habit. This characterization is based on Peirce's idea of a sign as a mediation between the interpretant of the sign and its object. This is why we have, for example, 3 1 in which

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3 describes the object, 2 describes the sign, and 1 describes the interpretant. Thus, we obtain

O	S	I
3	2	1.

My classification, however,

follows Peirce's definition of sign, in which he considers a sign as a type of First, the object as a type of Second, and the interpretant as a type of Third. Thus in my classification I obtain

I	O	S
3	2	1.

Considering my ordering, we can arrange in a combinatorial way Peirce's three-trichotomies of signs in the following way:

	S	-	O	-	I
X:	3	-	3	-	3
IX:	3	-	3	-	2
VIII:	3	-	2	-	2
VII:	2	-	2	-	2
VI:	3	-	3	-	1
V:	3	-	2	-	1
IV:	2	-	2	-	1
III:	3	-	1	-	1
II:	2	-	1	-	1
I:	1	-	1	-	1

The three-trichotomies yield the well known ten classes of signs (see Graph 6). The first column (S) stands for the sign (or for the sign related to itself). The second column (O) stands for the object (or for the sign related to its object). The third column (I) stands for the interpretant (or for the sign related to its interpretant). (See also Graph 5.)

The next trichotomies considered by Peirce yield twenty-eight classes of signs (letter to Lady Welby of December 14, 1908). They are the six-trichotomies into which Peirce expanded the division of signs, object and interpretant by considering two types of objects (immediate and dynamical) and three types of interpretant (immediate, dynamical and final) which are the past, present and future meaning of the sign, respectively.

In fact, the formerly considered three-trichotomies of signs are only a subset of the six-trichotomies of signs later introduced.

We can then have a new arrangement in which in the first column, the column related to the sign, we will find one qualisign, six sinsigns and twenty-one legisigns (whereas in the former arrangement we have, in the first column, one qualisign, three sinsigns and six legisigns):

		S	IO	DO	II	DI	FI
X	28:	3	3	3	3	3	3
	27:	3	3	3	3	3	2
	26:	3	3	3	3	2	2
IX	25:	3	3	3	2	2	2
	24:	3	3	2	2	2	2
VII	23:	3	2	2	2	2	2
IV	22:	2	2	2	2	2	2
	21:	3	3	3	3	3	1
	20:	3	3	3	3	2	1
	19:	3	3	3	2	2	1
	18:	3	3	2	2	2	1
	17:	3	2	2	2	2	1
	16:	2	2	2	2	2	1
	15:	3	3	3	3	1	1
	14:	3	3	3	2	1	1
	13:	3	3	2	2	1	1
	12:	3	2	2	2	1	1
	11:	2	2	2	2	1	1
VIII	10:	3	3	3	1	1	1
	9:	3	3	2	1	1	1
VI	8:	3	2	2	1	1	1
III	7:	2	2	2	1	1	1

	6:	3	3	1	1	1	1
	5:	3	2	1	1	1	1
	4:	2	2	1	1	1	1
V	3:	3	1	1	1	1	1
II	2:	2	1	1	1	1	1
I	1:	1	1	1	1	1	1

Even though Peirce did not give a triangular arrangement of these combinations, it is very easy to construct all the arrangements given in the six-trichotomies following the same pattern as for the three-trichotomies (see Graph 9).

In this arrangement, 28 corresponds to X of the three-trichotomies 22 corresponds to IV, 1 corresponds to I, and so forth. Furthermore, we would have the 4, 3, 2, 1 arrangement of Peirce's previous triangle for the ten signs of the three-trichotomies (see Graph 6).

Another triangular arrangement for the six-trichotomies could be as in see Graph 10.

All commentators have been very concerned with Peirce's ten-trichotomies of signs that yield sixty-six classes of signs. Most of them, no matter their differences, agree on one crucial issue: those ten-trichotomies are final.<sup>15</sup>

My position is exactly the opposite. In other words, I think that the ten-trichotomies are not final. My main reasons for this claim are:

(a) To consider the ten-trichotomies as final would be in contradiction to Peirce's conception of Tychism and Synechism involved in his metaphysical conception of evolution. According to Peirce, Synechism (or continuity) is that position that positively claims that, given any fact, there is a law that can explain that fact. Tychism, in turn, is the theory according to which, given any law, there is always a fact which that law cannot explain.

(b) The theory of Tychism and Synechism are closely bound up with Peirce's doctrine of the categories of Firstness, Secondness and Thirdness, mainly because these categories are the ones through which Peirce thought that the universe should be interpreted.

(c) Peirce's combinatorial system is related also to Semiotics because the latter, according to him, covers any possible sign in the world. Peirce claimed that human beings live in a universe of signs. In fact, the universe itself can be

<sup>15</sup> For example, A. Burks and P. Weiss, «Peirce's Sixty-six Signs», *Journal of Philosophy*, Vol. XLII, no. 14 (1945), 383-8; G. Sanders, «Peirce's Sixty-six Signs?», *Transactions of the Charles S. Peirce Society* 6 (1970), 3-16; T. Kondo, «Peirce's Interpretant: An Introductory Survey» (in Japanese) (1986), 79-94. R. Marty, *op. cit.*, is an exceptional case.

viewed as an enormous system of signs. Then if we analyze the different components of semiosis ("an act which is or involves a cooperation of the three subjects such as a sign, its object and its interpretant")<sup>16</sup> we can know better the real laws operating in nature (here is also involved Peirce's own brand of realism).

(d) Considering (a)-(c) together as being essential to the principles ruling Peirce's trichotomies, we will have:

– Tychism: everything in the universe evolves. The universe is composed of signs. Therefore, we will always have new types of signs that the former classifications did not cover. For example, the three-trichotomies do not consider signs according to the division of different types of interpretants, or different kinds of objects. This is a novelty that the three-trichotomies did not take into account. Furthermore, the six-trichotomies did not consider, for example, the different types of objects according to modalities.

– Synechism: we always are able to find a classification that encompasses those novelties. For example, the six-trichotomies encompass the signs taking into account the three types of interpretants and the two types of objects. And the ten-trichotomies consider the types of objects according to modalities.

Nevertheless, we cannot stop there. Tychism and Synechism require continual novelties and further classifications encompassing those novelties.

Even Peirce himself explicitly acknowledged the necessity of moving forward to new classifications and new trichotomies. For example, in a letter to Lady Welby (December 23, 1908), he wrote: "Each of these two Objects [Immediate and Dynamical] may be said to be capable of either of the three Modalities [possible object, actual fact or occurrence, and a necessitant]."<sup>17</sup> Peirce considered here the six-trichotomies as incomplete, and he needed to move forward for more complete trichotomies, for example, the ten-trichotomies.

In the ten-trichotomies, we get sixty six combinations of signs:

	S	IOP	IOA	ION	DOP	DOA	DON	II	DI	FI
66:	3	3	3	3	3	3	3	3	3	3
65:	3	3	3	3	3	3	3	3	3	2
64:	3	3	3	3	3	3	3	3	2	2
63:	3	3	3	3	3	3	3	2	2	2
62:	3	3	3	3	3	3	2	2	2	2
61:	3	3	3	3	3	2	2	2	2	2
60:	3	3	3	3	2	2	2	2	2	2
[...]										

<sup>16</sup> CP 5.384.

<sup>17</sup> See A. Burks and P. Weiss, *op. cit.*, p. 387.

7:	2	2	2	1	1	1	1	1	1	1
6:	3	3	1	1	1	1	1	1	1	1
5:	3	2	1	1	1	1	1	1	1	1
4:	2	2	1	1	1	1	1	1	1	1
3:	3	1	1	1	1	1	1	1	1	1
2:	2	1	1	1	1	1	1	1	1	1
1:	1	1	1	1	1	1	1	1	1	1

In this arrangement S stands for "sign", IOP for "immediate object as a possible object", IOA for "immediate object as an actual object", ION for "immediate object as a necessary thing", DOP stands for "dynamical object as a possible object", and so forth.

The first triangular arrangement for the ten-trichotomies should now appear as in Graph 11, and the second triangular arrangement as in Graph 12.

It is crucial to emphasize that if we examine the patterns of all these trichotomies we will discover a remarkable similitude with Llull's *ars combinatoria*. It is generally accepted (after Burks and Weiss stated it) that  $n$ -trichotomies yield  $1+n+(n+\dots+2+1)$  or  $(n+1)(n+2)/2$  classes.<sup>18</sup> But if we look at it from Llull's point of view, those trichotomies are combinations with repetitions (as in the *Ars demonstrativa*) of three elements taken 3, 6, or 10 at a time:

$$\binom{3+3-1}{3} = \binom{5}{3} = \frac{5 \cdot 4 \cdot 3}{3 \cdot 2 \cdot 1} = 10$$

$$\binom{3+6-1}{6} = \binom{8}{6} = \frac{8 \cdot 7 \cdot 6 \cdot 5 \cdot 4 \cdot 3}{6 \cdot 5 \cdot 4 \cdot 3 \cdot 2 \cdot 1} = 28$$

$$\binom{3+10-1}{10} = \binom{12}{10} = \frac{12 \cdot 11 \cdot 10 \cdot 9 \cdot 8 \cdot 7 \cdot 6 \cdot 5 \cdot 4 \cdot 3}{10 \cdot 9 \cdot 8 \cdot 7 \cdot 6 \cdot 5 \cdot 4 \cdot 3 \cdot 2 \cdot 1} = 66$$

I do not think that Peirce used Llull's combinations without repetitions (even though Peirce was trying to find the truth as Llull did before him), mainly because:

<sup>18</sup> See Charles S. Peirce, *Manuscripts and Letters*, ed. R.S. Robin (Boston: Univ. of Massachusetts Press, 1967).



- (i) Combinations without repetitions would require  $\binom{m}{r}$  where  $r \leq m$ .

But, in Peirce's case, for the three-trichotomies the number of signs would become too restrictive, since  $\binom{3}{3} = 1$ , i.e. only one combination would be obtained.

(ii) Peirce does not have the problem that Llull had with his combinations with repetitions (*Ars demonstrativa*). According to Llull, BB, for instance, could be interpreted as "Good is good"; but this is an analytic statement which gives us no factual information. However, in Peirce's three-trichotomies, 3-3-3, for example, does not mean "legisign, legisign, legisign". The first 3 is related to the sign (so it is a legisign); the second one is a 3 related to the object of the sign (so it is a symbol); and the third 3 is related to the interpretant (so it is an argument). Therefore 3-3-3 points essentially to an argument.

So, we can say that these are the first three-trichotomies. However, we can obtain further trichotomies that will show new aspects of the sign, the object and the interpretant. All the trichotomies show a quaternary-ternary pattern (see Graph 13).

## PART 2: TIME

### V. Peirce

Peirce frequently dealt with the problem of time, but he never gave, as far as I know, a systematic exposition of his theory of time. What we find in the mathematical, logical and philosophical manuscripts are sketchy and fragmentary writings.

Peirce is one of the few, who, in the last century, conceived time from a topological point of view, that is to say one in which the only important issues are those related to topological invariants. For example, in a letter to W.E. Story (March 22, 1896), he said that "The science of Time receives a brief chapter, chiefly because it affords an opportunity of studying true continuity". Time is true continuity and it is better understood from a topological point of view than from the metric one. The continuum as it is studied by analysis is, according to Peirce, a pseudo-continuum; only the continuity of time, as it is studied by topology, is the true continuity.

Peirce endorsed a relational view of time. Thus, in Ms. 94 (1894), he claimed that "time is that by the variations of which individual things have inconsistent characters."<sup>19</sup> Thus, to be alive and to be dead are inconsistent states;

<sup>19</sup> Leibniz said something similar in a letter to De Volder (June 20, 1703): «Time is the order of possible inconsistencies.»

but at different times the same body may be alive and dead".<sup>20</sup> This is another way of saying that time is the universal interconnection among non-contemporary events. But this is a relational conception of time.

Furthermore, and consistently with his relational view, Peirce conceived time as being cyclical. On the one hand, he defined a cycle as a change which returns onto itself, so that the final state of things is very similar to the initial state. On the other hand, since, first of all, time has no limits, and secondly, one of the properties of time is that any of its portions is bound by two instants, then there must be "a connection of time ring-wise". But time is also a true continuum because the instants in it are individually indistinguishable in their very existence.<sup>20</sup>

The cyclical theory of time was a common view in the 19<sup>th</sup> century. Not only Nietzsche, but also Poincaré and Zermelo, defended it. According to Peirce, that theory postulates: (a) the universe is a closed system containing only a finite number  $n$  of elementary particles, (b) time has no beginning or end, i.e. it is unbounded. Thus the definite "time direction" loses its significance, (c) time must be relational (Ms. 137, 1904), and (d) the universe will travel this circle only once. This is an obvious conclusion following from Leibniz's principle of identity of indiscernibles. We must then conclude, with Peirce, that time is finite but unbounded.<sup>21</sup>

The relation *before* can be depicted by the points of a circle, provided that we restrict its scope. However, we have to have a singular point outside the circle. We need to exempt one point on the circle from this ordering, to make the whole representation consistent with the cyclical view (see Graph 14).

According to my view, there is a double temporal dimension in Peirce's combinatorial system. First, there is a temporal aspect related to the signs. This is because (i) the process of semiosis (the one that provides the elements of the classification according to the sign, the object and the interpretant) has to converge, because it cannot be an open branch or a straight line. The sign is related to the object and the interpretant, and the object is related to the other elements. This is a closed process, not an open one. Consequently, it can be represented by a circle with those three elements on its circumference. (ii) The object has a temporal dimension, because the dynamical object (or real object) is completely known only piece by piece through the immediate object. The immediate object is only a hint that allows the dynamical object to manifest

<sup>20</sup> CP 1.497 (1896).

<sup>21</sup> For a more complete account, see B.C. van Fraassen, *An Introduction to the Philosophy of Time and Space* (New York: Random House, 1970), ch. III.

itself piece by piece, and this process obviously involves a temporal process. (iii) The relation between the sign and its interpretant is a relation of significance. This means that we can conceive the immediate, the dynamical and the final interpretants as the past, present and future meaning of a sign. Then the concept of interpretant has as well a temporal dimension, and (iv) sign, object and interpretant are manifestations of Peirce's categories.

Second, Peirce himself related his categories to time,<sup>22</sup> connecting Secondness to past, and Thirdness to future. Present, according to Peirce, has no independent existence. It is at best something like a point instant;<sup>23</sup> it is half past and half to come.<sup>24</sup> In this view, the present would be the zone where the actual (Secondness), the necessary (Thirdness) and the possible (Firstness) mingle.

It seems, therefore, that all the Peircean combinations of signs have a temporal dimension.

To conclude: in Peirce (we will see something similar in Leibniz), Time looks principally like an interconnection among categories and derivatively as an interconnection among the signs of this world.

## VI. Leibniz

In Leibniz's work, we find that time is also conceived as relational.

Some scholars, like Russell, believed that time, according to Leibniz, is an ideal entity. This is so because if time is a type of relation, it has no existence apart from the things it relates. But, independently of the accuracy of Russell's interpretation of Leibniz on time, in that interpretation, time is ideal because it is relational.<sup>25</sup>

The usual view is that Leibniz's time consists solely in relations among *phenomena bene fundata*. Thus, in the *Monadology*, temporal relations are conceived as phenomenal ones; they achieve their reality through being well founded in monads and their states. In this conception, again, time is conceived as relational.

Finally, if we interpret Leibniz's theory of time to be based on relations among monadic states, time will be conceived again as relational.

<sup>22</sup> See *Minute Logic*, Chapter I (1902).

<sup>23</sup> CP 1.38 (1890).

<sup>24</sup> CP 6.126 (1892).

<sup>25</sup> Bertrand Russell wrongly believed that time is ideal, because he endorsed an ontology which denies the existence of relational facts, such as «a is before b». See H. Ishiguro, *Leibniz's Philosophy of Logic and Language* (New York: Cornell University Press, 1972).

I agree with R. Arthur who claims that Leibniz's theory of time regards time principally as a structure of relations among *monadic states*, and only derivatively as a structure of relations among *phenomena bene fundata*.<sup>26</sup> Time is an abstract entity but objective (not ideal in Russell's sense); thus, Leibniz, in his fifth letter to Clarke said that time should be considered in abstraction of things. He distinguished between abstract time and concrete times. The parts of abstract time are themselves indiscernible (real continuum). The parts of concrete time are distinguishable by reference to the states and events occurring at them. Since the monads are the only substances that actually exist, and temporal relations are grounded at the metaphysical level, we can conclude that time is principally a universal interconnection of all monadic states by the relations of simultaneity, before or after. Only derivatively is time an interconnection of events or *phenomena bene fundata*. At this level, time is nothing but "things existing in time" like space is nothing at all without bodies or the possibility of placing bodies (see, for example, Leibniz's second letter to Clarke).

According to Leibniz, time is, from a topological point of view, a real continuum. For example, in the *Metaphysical Foundations of Mathematics* (c. 1714), Leibniz stated that "... a straight line and time, or in general, any continuum, can be subdivided to infinity". Following B. C. van Fraassen,<sup>27</sup> we can say that to be straight or to be curved are not topological invariants of a line. Thus the line can also be conceived as a circle with a missing point. This circle perfectly represents one of the main aspects of time: to be unbounded (with no beginning or end). In his fifth letter to Clarke, Leibniz says that we can conceive the possibility that the universe began sooner that it actually did, because time is only an abstract possibility (see Graph 15).

Finally, we need to remember that, according to Leibniz, (1) the simple symbols represent, at the metaphysical level, the monads, and (2) the compound symbols represent the *phenomena bene fundata*, which are the manifestations of the combinations of monads. Therefore, we must conclude, that if the time among monads is the foundation of the time among *phenomena bene fundata*, then Leibniz's combinatorial system has a temporal dimension, because through the combinations, temporal relations are represented. This is because any combination represents either temporal relations among monads, or temporal relations among *phenomena bene fundata*. Therefore the combinations always have temporal connotations.

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<sup>26</sup> See R. Arthur, «Leibniz's Theory of Time» in *The Natural Philosophy of Leibniz*, ed. K. Okruhlik (Dordrecht: Reidel, 1985), pp. 263-313.

<sup>27</sup> *Op. cit.*, pp. 59-62.

## VII. Llull

Llull did not write very much about time. However, I want to claim that, on the one hand, some of Llull's ideas about time can be related to those of Aristotle and of the Aristotelian medieval philosophers. On the other hand, Llull anticipated, even though in a very cryptic way, Leibniz's conception of time as I have interpreted it above.

Aristotle defined "time" in *Physics* (Book IV, 219b) as the measure of motion with respect to before and after (the common medieval definition is very close to Aristotle's). But this definition of time looks like a definition of *duration* rather than of time. Moreover, Aristotle presented, as well, a series of arguments showing that the world and motion have no beginning and shall have no end. Then, time, which is based on motion, shares those properties with motion.

Llull mentioned *duration* as one of the dignities of God in the several formulations of Figure A (i.e. *Ars demonstrativa*, or *Ars generalis ultima*). In the *Ars generalis ultima* Llull said that is possible to express those dignities in an abstract way, in a concrete way, and in symbols (see Graph 16).

"Duration" seems to be that relation that gives an order to the other dignities. It is an abstract entity, which, concretely understood, would be eternity.<sup>28</sup>

Llull in the alphabet of the *Ars generalis ultima* talks about time as a rule. The rules are general questions included in the alphabet. Thus, the letter *H* is *tempus* and the general question is *quando*?

In the XII Part of *Ars generalis ultima* he defined the terms used in the Art. Definition 23 is a definition of time: "Time is the entity within which created beings are begun and renewed. Or: Time is that thing made up of many nows with reference to before and after." In this definition, Llull seems to be representing a transition between Newton and Leibniz: Time is an absolute, and time is an order among non-contemporary events. Incidentally, Leibniz said, on some occasions, that time is made up (or composed) of many nows.

I think that this conception of time as a relation, has more support in Llull's writings than the Newtonian one. In defense of my position, I want to stress the following:

(a) Time is one of the rules of the *Ars magna*. It is a criterion for ordering events.

(b) It is worth remarking that Giordano Bruno, an important link between Llull and Leibniz concerning combinatoria, said that the rules or questions in Llull's Art are the *syncategoremata* of that Art. In addition, medieval logicians

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<sup>28</sup> Ramon Llull defined duration as «that thing that allows Goodness and the other principles [dignities] to endure.»

considered *incipit* and *desinit* i.e. "begins" and "ends", two temporal distinctions, also as *dictiones syncategoremata*. We have to remember that syncategorematic terms or expressions in medieval logic are, more or less, what in modern logic we call syntactical or logical terms. They have no meaning by themselves in isolation, but only in context. The categorematic terms, in medieval logic, are the non-syntactical terms in contemporary logic. They have meaning by themselves in isolation.

Then we can say that time, being a syncategorematic expression, is only a relation among entities which function referentially. So, it would be a relation among *phenomena bene fundata*.

What about the conception of time as a relation among monads? I think that time considered as duration in Figure A, expresses that type of conception. Llull said that the absolute principles or dignities, can be "joined or combined with" one another. Since *duration* is another dignity, it can represent a temporal order in the domain of the dignities. This order is the principal one; it has no beginning or end (duration or time, in a concrete way is *eternal*). This order among dignities is at the base of that other time that provides order to the events of this world. All this is consistent with Llull's idea that the things in this world are manifestations of the dignities of God.

Even though Llull did not consider the topological interpretation of the structure of time, it is not inconsistent to say that with him time can be conceived as in Leibniz's case: that is, as a circle with a missing point, finite but unbounded. Thus, Llull's idea of eternity was related to the concept of no beginning and no end. And since this world is a manifestation of the divine dignities, we can conclude that, in this world, the relation of time is a circular one.

Finally, since what we primarily combine in Llull's combinatory art are the divine dignities, and those dignities have a temporal dimension, the elements of his *ars combinatoria* have also a temporal dimension. Those combinations involve time as in the combination of BD in the Third Figure, or of BCD in the Fourth Figure (ternary period), because the letter D (Duration) is present in those combinations.

## VIII. Conclusions

Let me sketch the main conclusions relating Llull's, Leibniz's and Peirce's conception of *ars combinatoria* and Time.

Llull influenced both Leibniz and Peirce in their ideas of *ars combinatoria*. All of them conceived it as an art or method for finding truth. The *ars combinatoria*, in all these authors, is an important part of logic. In Llull, his *Logica nova* is that logic which studies the "artistic" logical structure of his art.

In Leibniz his *Ars inveniendi* is almost an *Ars combinatoria*. In Pierce, as well, his logic is semiotics or a General Theory of Signs, and so it is related to his *ars combinatoria*. Leibniz and Peirce used, in their *ars combinatoria*, the combinations given by Llull in his Art. Both used too, some of Llull's figures. Leibniz used the rectangular figure related to the four elements. Peirce, in turn, used the same triangular figures in which Llull combined the letters of his alphabet. Llull in his *ars combinatoria* basically combined dignities. Leibniz basically combined monads, and Peirce fundamentally combined categories.<sup>29</sup>

These three authors had a realistic conception of their *ars combinatoria*. Metaphysical entities, such as the dignities, the monads and the categories, really operate in nature.

It is important to emphasize that Peirce himself acknowledged that Leibniz was the philosopher with whom he identified more than with any other. There is an obvious parallelism between Leibniz's central concern with logic, and Peirce's work on logic. For both, the theory of combinations are essential parts of their logic. The connection between logic and metaphysics is also obvious, not only in Leibniz's work, but in Peirce's as well.

Finally, Peirce, following Leibniz, tried to create an automatic universal language with a logical mechanism in which the *characteristica* plays a central role, making such logical mechanism possible.

As for time, all of them have a metaphysical theory concerning it; and we can conclude that all defended a relational view of time. Both, Leibniz and Peirce, explicitly acknowledged this point. In Llull, it is a consequence that can be inferred from his writings on the subject. If we consider the topological structure of time, we can state that in these three authors, it is consistent to affirm that time can be conceived as circular, finite and unbounded.

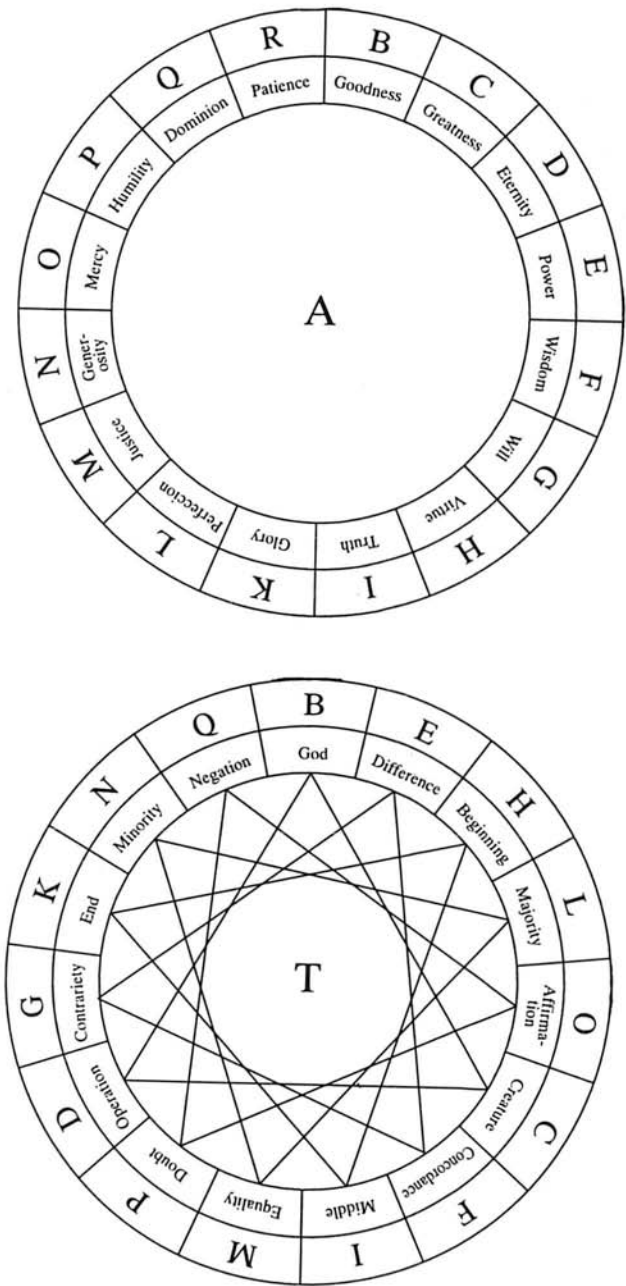
Finally, their conception of *ars combinatoria* is consistent with their views of the topological aspects of time. This is so, mainly because dignities, monads and categories have a temporal dimension.

It is then a historical fact that Llull influenced both Leibniz and Peirce, more strictly speaking in their *ars combinatoria* and, more broadly, in the temporal character that such an *ars combinatoria* has in all three of them.

ANA H. MARÓSTICA  
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<sup>29</sup> Incidentally, Peirce mentioned Llull in his writings mainly on two occasions: in 1893 (*CP* 4.36), when he criticized Llull, and in 1903 (*CP* 4.365), when he spoke of him with admiration.



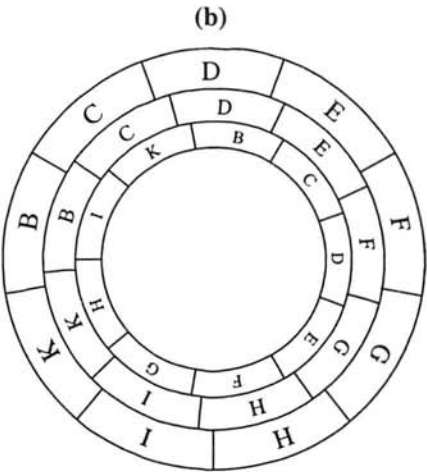
Graph 1



BC	CD	DE	EF	FG	GH	GI	IK
BD	CE	DF	EG	FH	GI	HK	
BE	CF	DG	EH	FI	GK		
BF	CG	DH	EI	FK			
BG	CH	DI	EK				
BH	CI	DK					
BI	CK						
BK							

(a)

Graph 2



1	2	3	4	5	6	7	8	9	10	11	12
BCD	BCE	BCF	BCG	BCH	BCI	BCK	BDE	BDF	BDG	BDH	BDI
13	14	15	16	17	18	19	20	21	22	23	24
BDK	BEF	BEG	BEH	BEI	BEK	BFG	BFH	BFI	BFK	BGH	BGI
25	26	27	28	29	30	31	32	33	34	35	36
BGK	BHI	BHK	BIK	CDE	CDF	CDG	CDH	CDI	CDK	CEF	CEG
37	38	39	40	41	42	43	44	45	46	47	48
CEH	CEI	CEK	CFG	CFH	CFI	CFK	CGH	CGI	CGK	CHI	CHK
49	50	51	52	53	54	55	56	57	58	59	60
CIK	DEF	DEG	DEH	DEI	DEK	DFG	DFH	DFI	DFK	DGH	DGI
61	62	63	64	65	66	67	68	69	70	71	72
DGK	DHI	DHK	DIK	EFG	EFH	EFI	EFK	EGH	EGI	EGK	EHI
73	74	75	76	77	78	79	80	81	82	83	84
EHK	EIK	FGH	FGI	FGK	FHI	FHK	FIK	GHI	GHK	GIK	HIK

Graph 3

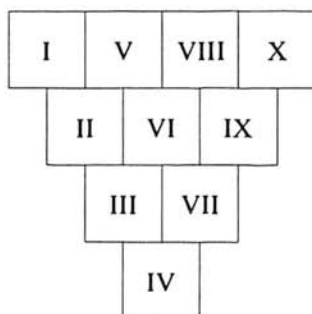
Graph 4

1	B C D t
2	B C t B
3	B C t C
4	B C t D
5	B D t B
6	B D t C
7	B D t D
8	B t B C
9	B t B D
10	B t C D
11	C D t B
12	C D t C
13	C D t D
14	C t B C
15	C t B D
16	C t C D
17	D t B C
18	D t B D
19	D t C D
20	t B C D

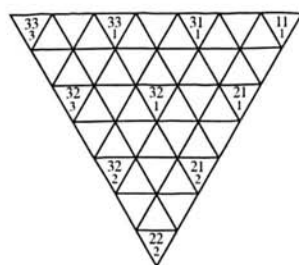
Graph 5

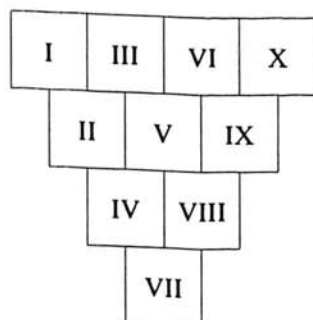
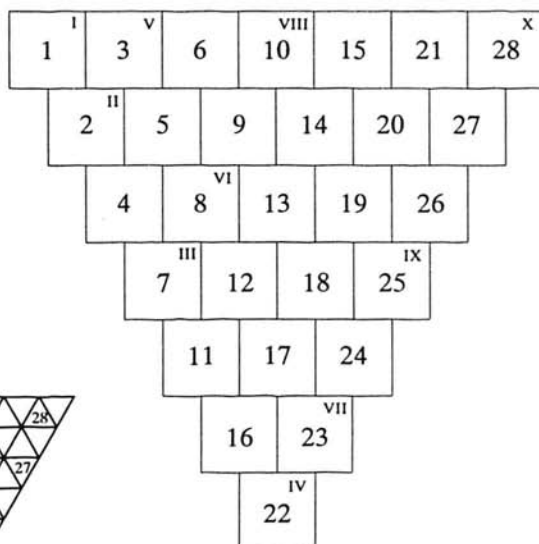
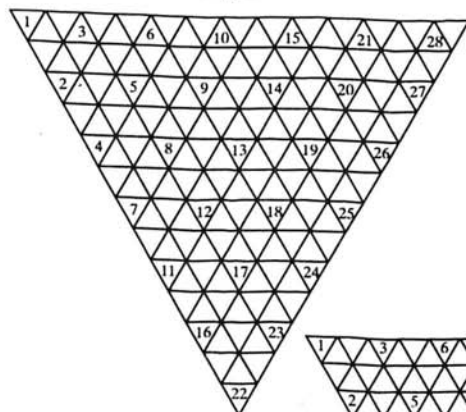
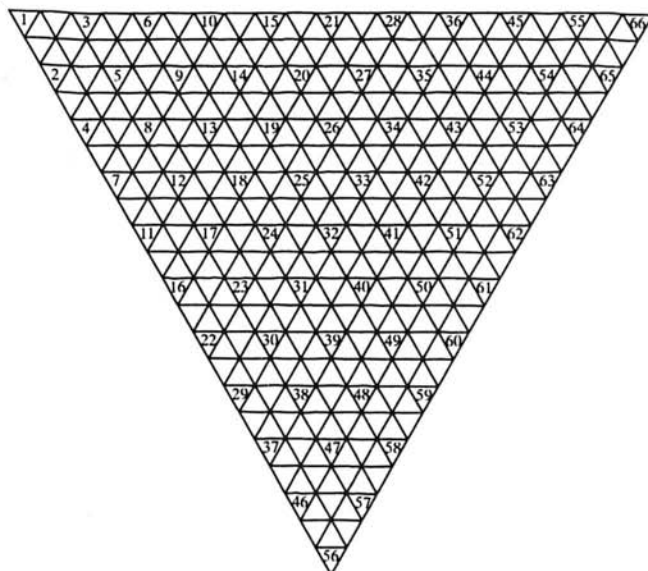
1 The sign related to itself	QUALISIGN It is a mere quality. It is Firstness.	SINSIGN It is an individual object or event. It is Secondness. But it is related to 1, so it is Firstness.	LEGISIGN It is a general type, a law, habit. It is Thirdness, but it is related to 1, so it is Firstness.
2 The sign related to its object	ICON It is an image of its object. It is Firstness, but it is related to 2, so it is Secondness.	INDEX (seme) It is some real relation between the sign and its object. It is Secondness.	SYMBOL It refers to the object that it denotes by virtue of a law. It is Thirdness, but it is related to 2, so it is Secondness.
3 The sign related an interpretant	RHEME (term) It is a sign of qualitative possibility. It is Firstness, but it is related to 3, so it is Thirdness.	DICENT SIGN It is a sign of fact, of actual existence. It is Secondness. But it is related to 3, so it is Thirdness.	ARGUMENT It is a sign of law, of reason. It is Thirdness.

Graph 6

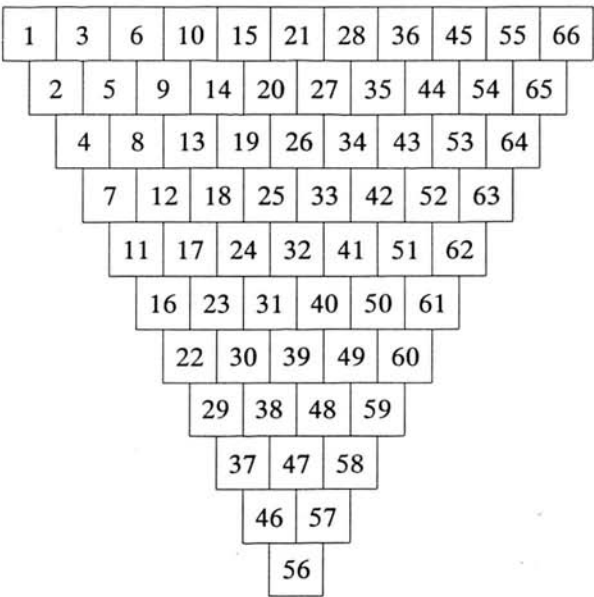


Graph 7

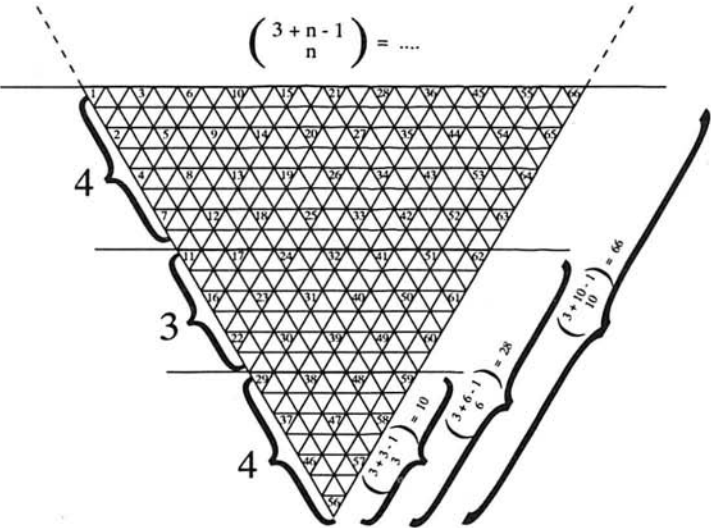


**Graph 8****Graph 10****Graph 9****Graph 11**

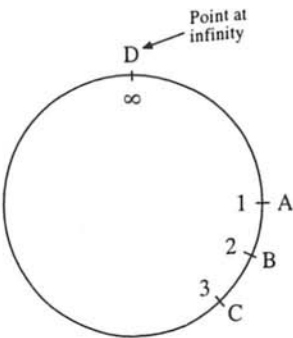
Graph 12



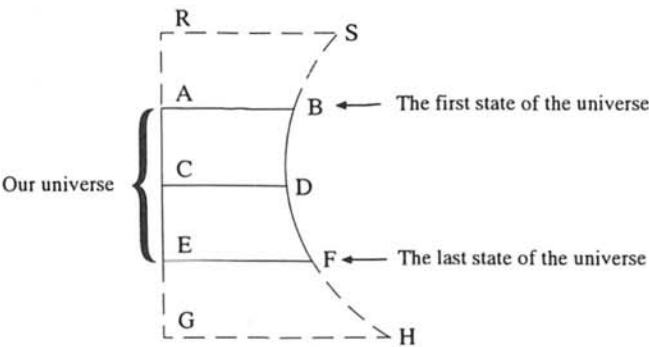
GRAPH 13



Graph 14



Graph 15



Graph 16

Symbol	Abstract Way	Concrete Way
B	Goodness	Good
C	Greatness	Great
D	Duration	Eternal
.	.	.
.	.	.
.	.	.

## RESUM

L'autora traça la influència de l'*Ars combinatòria* lul·liana, com a fonament d'una lògica o art inventiva, en Leibniz i en Peirce. Assenyala que tots tres eren realistes, que per tant cercaven un mètode de combinar categories d'entitats existents en la natura, un mètode que amb els dos darrers va donar peu a la recerca d'un llenguatge universal. Finalment sosté que tots tres tenien una visió relacional del temps, que, mirat des del punt de vista topològic, implica que el temps ha de ser circular, finit i sens límits.